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(54) Title: MINERAL-FIBER COMPOSITIONS

(57) Abstract

A biologically degradable mineral-fiber composition characterized by the following constituents in percent by weight: SiO_2: 45 to 60, Al_2O_3: less than 2, CaO 7: to 18, MgO: 4 to 10, Na_2O: 7 to 20, K_2O: 0 to 4, B_2O_3: 1 to 12, P_2O_5: 0 to 4, diverse: 0 to 5, Na_2O: + K_2O: 7 to 24, CaO + MgO: more than 15.5 and up to 25, BaO: 0 to 5, TiO_2: 0 to 4, Cr_2O_3: 0 to 1.5, Fe_2O_3: 0 to 3.

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Mineral-fiber compositions

The present invention relates to a mineral-fiber composition that is biologically degradable.

The prior art describes some mineral-fiber compositions which are said to be biologically degradable.

The biological degradability of mineral-fiber compositions is of great importance because various studies point out that mineral fibers with very small diameters in the range of less than 3 microns can be carcinogenic, while biologically degradable mineral fibers of such dimensions show no carcinogenicity.

However not only the biological degradability is of crucial importance but also the mechanical and thermal properties of the mineral fibers, or the products produced therefrom, the resistance of the mineral fibers and the processibility of the mineral-fiber composition.

For example mineral fibers are used to a great extent for insulation purposes. For these applications sufficient moisture-resistance is necessary.

Also, the mineral-fiber composition must permit processibility by known methods for producing mineral fibers with a small diameter, for example the centrifugal technique, in particular the inner centrifugal technique (this technique is described for example in US-PS 4 203 745).

The invention is based on the problem of providing a novel mineral-fiber composition that is characterized by

biological degradability, has good stability or resistance to moisture and is easy to process.

The invention is based on the finding that this problem can be solved by a mineral-fiber composition that has considerable amounts of alkali oxides and alkaline-earth oxides, and optionally phosphorus oxide.

It has turned out that such a mineral-fiber composition fulfills the combination of the necessary properties, namely biological degradability, resistance to moisture and good processibility.

The object of the invention is a mineral-fiber composition that is biologically degradable, characterized by the following constituents in percent by weight:

SiO_2	45 to 60
Al_2O_3	less than 2
CaO	7 to 18
MgO	4 to 10
Na_2O	7 to 20
K_2O	0 to 4
B_2O_3	1 to 12
P_2O_5	0 to 4
Diverse	0 to 5
$Na_2O + K_2O$	7 to 24
CaO + MgO	more than 15.5 and up to 25
BaO	0 to 5
TiO_2	0 to 4
Cr_2O_3	0 to 1.5
Fe_2O_3	0 to 3.

The inventive mineral-fiber compositions are processible by the centrifugal technique. The obtained fibers have good resistance to moisture. Surprisingly enough, the mineral-fiber compositions show biological degradability. The mean fiber diameter is preferably 10 microns or less, and is in particular between 2.5 and 5 microns.

The inventive mineral-fiber compositions preferably have the following constituents in percent by weight:

SiO_2	50	to	58
Al_2O_3	less than 2		
CaO	10	to	18
MgO	4	to	8
Na_2O	10	to	18
K_2O	0	to	2
B_2O_3	3	to	12
P_2O_5	0.5	to	4
Diverse	0	to	2
$Na_2O + K_2O$	10	to	21
CaO + MgO	16	to	24
BaO	0	to	4
TiO_2	0	to	3
Cr_2O_3	0	to	1
Fe_2O_3	0	to	2.

The inventive mineral-fiber compositions have in particular the following constituents in percent by weight:

SiO_2	50	to	57
Al_2O_3	0.5	to	1.5
CaO	11	to	16
MgO	4.5	to	6
Na_2O	12	to	17

K_2O	0.5 to 1
B_2O_3	5 to 11
P_2O_5	1 to 3
Diverse	0.5 to 1.0
$Na_2O + K_2O$	11 to 17
$CaO + MgO$	16 to 22
BaO	0 to 3
TiO_2	0 to 2
Cr_2O_3	0 to 0.5
Fe_2O_3	0 to 1.5.

The inventive mineral-fiber compositions preferably have less than 55% silicon dioxide.

It is also particularly preferred that the compositions contain more than 5 percent by weight, in particular more than 6 percent by weight, magnesium oxide.

Barium oxide is preferably added in exchange for calcium oxide.

Biological degradability can be increased by adding phosphorus pentoxide. The inventive compositions therefore preferably contain at least 0.5 percent by weight P_2O_5.

It is advantageous to add titanium oxide, chromium oxide and/or iron oxide to reduce the corrosive properties of the melt.

The moisture-resistance of the inventive mineral-fiber compositions was determined by a standard method known as the DGG method. In the DGG method 10 g finely ground mineral with a grain size between about 360 and 400 microns is held at the boiling point for five hours in 100 ml water. After quick cooling of the material the solution is filte-

red and a certain volume of the filtrate evaporated to dryness. The weight of the thus obtained dry material permits the amount of mineral dissolved in the water to be calculated. The amount is stated in milligrams per gram of tested mineral.

The biological degradability of the inventive mineral compositions was tested by introducing 1 g of the mineral powder, as described for the DGG method, into a physiological solution with the composition stated below and a pH value of 7.4:

NaCl	6.78
NH_4Cl	0.535
$NaHCO_3$	2.268
$NaH_2PO_4H_2O$	0.166
(Na_3 citrate) $2H_2O$	0.059
Glycine	0.450
H_2SO_4	0.049
$CaCl_2$	0.022

Dynamic test conditions were selected as are described in Scholze and Conradt. The flow rate was 300 ml/day. The duration of the test was 14 days. The results are stated as percent of SiO_2 in the solution x 100 after 14 days.

The invention shall be described in more detail in the following with reference to examples.

Example 1

A composition was produced with the following constituents in percent by weight:

SiO_2	56
Al_2O_3	0.5
CaO	15
MgO	4.0
Na_2O	16.2
K_2O	0.8
B_2O_3	5.5
P_2O_5	1.5
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 32 mg/g was determined.

The above-described test for biological degradability yielded a value of 615.

Example 2

A composition was produced with the following constituents in percent by weight:

SiO_2	54.5
Al_2O_3	0.5
CaO	15
MgO	4.0
Na_2O	16.2

K_2O	0.8
B_2O_3	5.5
P_2O_5	3.0
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 32 mg/g was determined.

The above-described test for biological degradability yielded a value of 690.

Example 3

A composition was produced with the following constituents in percent by weight:

SiO_2	56
Al_2O_3	0.5
CaO	13
MgO	6
Na_2O	16.2
K_2O	0.8
B_2O_3	5.5
P_2O_5	1.5
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 32 mg/g was determined.

The above-described test for biological degradability yielded a value of 615.

Example 4

A composition was produced with the following constituents in percent by weight:

SiO_2	54.5
Al_2O_3	0.5
CaO	13
MgO	6
Na_2O	16.2
K_2O	0.8
B_2O_3	5.5
P_2O_5	3
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 32 mg/g was determined.

The above-described test for biological degradability yielded a value of 690.

Example 5

A composition was produced with the following constituents in percent by weight:

SiO_2	56

Al_2O_3	0.5
CaO	16
MgO	6
Na_2O	13.2
K_2O	0.8
B_2O_3	5.5
P_2O_5	1.5
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 22 mg/g was determined.

The above-described test for biological degradability yielded a value of 585.

Example 6

A composition was produced with the following constituents in percent by weight:

SiO_2	54.5
Al_2O_3	0.5
CaO	16
MgO	6
Na_2O	13.2
K_2O	0.8
B_2O_3	5.5
P_2O_5	3
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 22 mg/g was determined.

The above-described test for biological degradability yielded a value of 660.

Example 7

A composition was produced with the following constituents in percent by weight:

SiO_2	54.5
Al_2O_3	1
CaO	16
MgO	6
Na_2O	13.2
K_2O	0.8
B_2O_3	6.5
P_2O_5	1.5
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 17 mg/g was determined.

The above-described test for biological degradability yielded a value of 570.

Example 8

A composition was produced with the following constituents in percent by weight:

SiO_2	53
Al_2O_3	1
CaO	16
MgO	6
Na_2O	13.2
K_2O	0.8
B_2O_3	6.5
P_2O_5	3
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 17 mg/g was determined.

The above-described test for biological degradability yielded a value of 645.

Example 9

A composition was produced with the following constituents in percent by weight:

SiO_2	50.5
Al_2O_3	1.5
CaO	16
MgO	8
Na_2O	12.2

K_2O	0.8
B_2O_3	6.5
P_2O_5	4
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 7 mg/g was determined.

The above-described test for biological degradability yielded a value of 660.

Example 10

A composition was produced with the following constituents in percent by weight:

SiO_2	50.5
Al_2O_3	1.5
CaO	18
MgO	6
Na_2O	10.7
K_2O	0.8
B_2O_3	8
P_2O_5	4
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 7 mg/g was determined.

The above-described test for biological degradability yielded a value of 660.

Example 11

A composition was produced with the following constituents in percent by weight:

SiO_2	55
Al_2O_3	1
CaO	11
MgO	5
Na_2O	14.2
K_2O	0.8
B_2O_3	11.5
P_2O_5	1
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 31 mg/g was determined.

The above-described test for biological degradability yielded a value of 600.

Example 12

A composition was produced with the following constituents in percent by weight:

SiO_2	56.5

Al_2O_3	0.5
CaO	11
MgO	5
Na_2O	14.2
K_2O	0.8
B_2O_3	10.5
P_2O_5	1
Diverse	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 36 mg/g was determined.

The above-described test for biological degradability yielded a value of 620.

Example 13

A composition was produced with the following constituents in percent by weight:

SiO_2	58.0
Al_2O_3	0.5
CaO	13.0
MgO	7.0
$Na_2O + K_2O$	13.5
B_2O_3	8.0.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 21 mg/g was determined.

The above-described test for biological degradability yielded a value of 515.

Example 14

A composition was produced with the following constituents in percent by weight:

SiO_2	57.0
Al_2O_3	0.5
Fe_2O_3	1.0
CaO	13.0
MgO	7.0
$Na_2O + K_2O$	13.5
B_2O_3	8.0.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 22 mg/g was determined.

The above-described test for biological degradibilty yielded a value of 480.

Example 15

A composition was produced with the following constituents in percent by weight:

SiO_2	58.0
Al_2O_3	0.5
CaO	9.5
MgO	7.0
$Na_2O + K_2O$	17.0
B_2O_3	8.0.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 36 mg/g was determined.

The above-described test for biological degradability yielded a value of 550.

Example 16

A composition was produced with the following constituents in percent by weight:

SiO_2	58.0
Al_2O_3	0.5
CaO	13.0
MgO	7.0
$Na_2O + K_2O$	17.0
B_2O_3	4.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 27 mg/g was determined.

The above-described test for biological degradability yielded a value of 515.

Example 17

A composition was produced with the following constituents in percent by weight:

SiO_2	57.5
Al_2O_3	0.5
CaO	13.5
MgO	6.5
$Na_2O + K_2O$	17.0
B_2O_3	4.5
Cr_2O_3	0.5.

This mineral composition could be processed by the centrifugal technique.

Using the above-described DGG method a value of 25 mg/g was determined.

The above-described test for biological degradability yielded a value of 490.

Claims

1. A mineral-fiber composition that is biologically degradable, characterized by the following constituents in percent by weight:

SiO_2	45 to 60
Al_2O_3	less than 2
CaO	7 to 18
MgO	4 to 10
Na_2O	7 to 20
K_2O	0 to 4
B_2O_3	1 to 12
P_2O_5	0 to 4
Diverse	0 to 5
$Na_2O + K_2O$	7 to 24
CaO + MgO	more than 15.5 and up to 25
BaO	0 to 5
TiO_2	0 to 4
Cr_2O_3	0 to 1.5
Fe_2O_3	0 to 3.

2. The mineral-fiber composition of claim 1, characterized by the following constituents in percent by weight:

SiO_2	50 to 58
Al_2O_3	less than 2
CaO	10 to 18
MgO	4 to 8
Na_2O	10 to 18
K_2O	0 to 2

B_2O_3	3	to	12
P_2O_5	0.5	to	4
Diverse	0	to	2
$Na_2O + K_2O$	10	to	21
$CaO + MgO$	16	to	24
BaO	0	to	4
TiO_2	0	to	3
Cr_2O_3	0	to	1
Fe_2O_3	0	to	2.

3. The mineral-fiber composition of claim 1 or 2, characterized by the following constituents in percent by weight:

SiO_2	50	to	57
Al_2O_3	0.5	to	1.5
CaO	11	to	16
MgO	4.5	to	6
Na_2O	12	to	17
K_2O	0.5	to	1
B_2O_3	5	to	11
P_2O_5	1	to	3
Diverse	0.5	to	1.0
$Na_2O + K_2O$	11	to	17
$CaO + MgO$	16	to	22
BaO	0	to	3
TiO_2	0	to	2
Cr_2O_3	0	to	0.5
Fe_2O_3	0	to	1.5.

4. The mineral-fiber composition of any of claims 1 to 3, characterized in that the content of silicon dioxide is less than 55 percent by weight.

5. The mineral-fiber composition of any of claims 1 to 4, characterized in that the content of magnesium dioxide is more than 5 percent by weight.

6. The mineral-fiber composition of any of claims 1 to 5, characterized in that the content of magnesium dioxide is more than 6 percent by weight.

INTERNATIONAL SEARCH REPORT

Inter. ..onal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C03C13/00 C03C13/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	EP,A,0 019 600 (OY PARTEK AB) 26 November 1980 see page 1, line 1 - page 4, line 34 ---	1-6
X	EP,A,0 399 320 (BAYER AG) 28 November 1990 see claims 1-3 ---	1-6
X	EP,A,0 412 878 (ISOVER SAINT-GOBAIN) 13 February 1991 see page 2, line 1 - page 5, line 1 --- -/--	1-6

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[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	GLASTECHNISCHE BERICHTE, vol. 64, no. 1, January 1991 FRANKFURT DE, pages 16-28, XP 000178832 R. M. POTTER ET AL 'Glass Fiber Dissolution in a Physiological Saline Solution' see page 26, left column, paragraph 3 - page 27, left column; table 2	1-6

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Information on patent family members

Inter. ...nal Application No
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